

REMARKS / ARGUMENTS

This letter is responsive to the Office Action mailed on May 5, 2004. The response is accompanied with a request for a two-month extension of time. Accordingly, the response is considered as being timely filed.

Further, this communication is in response is to a FINAL Office Action. Accordingly, this response is accompanied with a Request for Continued Examination with the appropriate funds.

By this response, the Applicant has amended claims 21, 22, 28 and 29, added new claim 34 and has deleted claim 27 without prejudice. Accordingly, the Applicant encloses funds of \$44 to cover the fees for one additional excess independent claim. The Applicant submits that no new matter has been added by these amendments.

With regards to the claims, the Applicant has amended claim 21 to specify that the amplification unit receives an input amplification signal and generates an output signal with compression and reduced noise under the control of the amplification control signal. Amended claim 21 further specifies that the apparatus includes a main noise reduction unit that is optionally connected to the input and the amplification unit for receiving the input signal and generating a noise reduced signal. Amended claim 21 further recites that the amplification input signal is the noise reduced signal when the main noise reduction is connected to the input and the amplification unit, otherwise, the input amplification signal is the single input signal. Support for this claim amendment is in lines 1 to 8 on page 2, and in lines 12 to 15 and 26 to 31 on page 5 of the application as filed. Accordingly, the Applicant submits that no new matter has been introduced with this claim amendment.

Since the Applicant has introduced the main noise reduction unit into claim 21, the Applicant has deleted claim 27 without prejudice. Further, the Applicant has revised the

claim dependencies of claims 22, 28 and 29 to depend from claim 21 instead of claim 27. Accordingly, the Applicant submits that no new matter has been introduced with these claim amendments.

The Applicant has also included new independent claim 34 which recites an apparatus, for reducing noise in an input signal. The apparatus includes an input for receiving the input signal and comprises a compression circuit for receiving a compression control signal and generating an amplification control signal in response; an amplification unit for receiving an input amplification signal and the amplification control signal and generating an output signal with compression and reduced noise under the control of the amplification control signal; an auxiliary noise reduction unit connected to the input for generating an auxiliary noise reduced signal, the compression control signal being the auxiliary noise reduced signal; and, a main noise reduction unit connected to the input and the amplification unit for receiving the single input signal and generating a noise reduced signal, the input amplification signal being the noise reduced signal. The main noise reduction unit employs a first noise reduction algorithm and the auxiliary noise reduction unit employs a second noise reduction algorithm, the second noise reduction algorithm being adapted to attack noise more aggressively than the first noise reduction algorithm. Support for this claim amendment is Figure 1, and lines 8 to 25 on page 5 of the application as filed.

The Applicant submits that none of the cited references teach an apparatus for reducing noise, as now claimed in claim 34, in which there are two noise reduction units in a first path and a second path wherein noise can be more aggressively attenuated in the second path and used a control signal that controls some of the processing that occurs in the first path for providing a cleaner output signal for the hearing aid user. Accordingly, the Applicant submits that claim 34 is novel and inventive over the cited references and should be allowed.

CLAIM REJECTIONS – 35 USC s. 102

In the Office Action, the Examiner made a novelty rejection to claims 21-22, 27 and 29 under 35 U.S.C. 102(b) as being anticipated by Lindemann et al. (U.S. 5,479,522) hereafter referred to as "Lindemann".

With regards to claim 21, the Examiner argued that Lindemann teaches a noise reduction apparatus that includes an input for receiving an input signal, a compression circuit (266) for receiving a compression control signal and generating an amplification control signal (for multiplier 268), an amplification unit (multiplier 268) for receiving the input signal and the amplification control signal and generating an output signal (LEFT OUT) with compression and reduced noise, and an auxiliary noise reduction unit (260, 262, 264) connected to the input for generating an auxiliary noise reduced signal (to compression circuit 266) where the compression control signal is the auxiliary noise reduced signal (see Fig. 11 and col. 12, lines 12-61 of Lindemann).

The Applicant respectfully submits that the Lindemann reference does not disclose the Applicant's invention as now claimed in claim 21. Firstly, the Applicant submits that Lindemann is directed towards a binaural hearing aid system in which the sound intensities of the left and right channels are used to shape the gain that is applied to these channels (hence the need for the MAG SQUARED BLOCK (260)). In contrast, the Applicant claims that the noise reduced signal is derived from a single input signal.

In addition, Lindemann teaches the extra step of modifying the left and right input signals prior to multiplication (i.e. blocks 268 and 270) with the output of the compression gain block (i.e. block 266) with frequency response adjustment vectors (i.e. LEFT GAIN and RIGHT GAIN vectors) that are a function of the audiogram measurements of the hearing loss of the hearing aid user. Further, Lindemann does not teach that this step is optional. Accordingly, the input signals are always modified prior to amplification.

In contrast, in amended claim 21, the Applicant claims that the amplification unit receives an amplification input signal and that the apparatus includes a main noise reduction unit that is optionally connected to the input and the amplification unit for receiving the single input signal and generating a noise reduced signal. Amended claim 21 further recites that the amplification input signal is the noise reduced signal input when the main noise reduction is connected to the input and the amplification unit, otherwise, the input amplification signal is the single input signal. The apparatus taught by Lindemann does not provide this flexibility. Lindemann does not teach that any blocks of his apparatus are optional.

The Applicant further notes that it is beneficial to provide an apparatus for reducing noise in which the main signal path is controlled optimally. For instance, there may be situations in which the sound quality is improved when no noise reduction is used in the main signal path. There are also other situations in which the sound quality is improved when noise reduction occurs in the main signal path. In particular, the Applicant notes that the objective of noise reduction is to affect a compromise between the degree of noise reduction (directly influencing listener fatigue), signal intelligibility and signal distortion. Typically, at low amounts of noise suppression, listener fatigue is noticeably reduced even though signal intelligibility slightly drops and distortion slightly increases. At larger amounts of noise suppression, listener fatigue is greatly reduced, however, the negative effects on signal intelligibility and distortion become noticeable. The best compromise depends greatly on the application. Under mission critical applications where intelligibility is paramount, it may be beneficial to use a different, possibly more aggressive, noise reduction scheme only in the compression path. This allows signal modifications by the compression controlled by a noise-reduced signal. This is advantageous because the compression circuitry is typically much less sensitive to artifacts than the human listener. Under situations where a listener is required to monitor noisy speech for long periods of time, it may be advantageous to provide noise reduction in the signal path preceding the amplification unit. The Applicant has found that the listener typically agrees that the reduction in listener fatigue is well worth the small drop in signal intelligibility and small increase in signal distortion. The Applicant's

apparatus as now claimed in claim 21 provides this functionality of optional noise reduction in the main signal path whereas the apparatus taught by Lindemann does not.

Accordingly, the Applicant respectfully submits that claim 21 is novel and inventive over the cited reference and is therefore allowable. Furthermore, since claims 22 to 24 and 28 to 30 depend from independent claim 21, and introduce other patentable features, the Applicant respectfully submits that claims 22 to 24 and 28 to 30 are also allowable.

With regards to claim 27, in the Office Action, the Examiner argued that Lindemann teaches a main noise reduction unit (265, left gain vector), for generating a noise reduced signal and supplying the noise reduced signal to the amplification unit (268) in place of the input signal.

Since the Applicant has deleted claim 27 without prejudice, the Applicant submits that this rejection is no longer applicable.

With regards to claim 29, in the Office Action, the Examiner argued that Lindemann teaches an apparatus as claimed in Applicant's claim 27 and that even though Lindemann does not explicitly disclose how the auxiliary unit is different from the main noise reduction unit it should be obvious for separating the auxiliary noise reduction unit from the main noise reduction unit.

In response, the Applicant submits that claim 29 no longer depends on claim 27, but rather depends from claim 21 which recites a main noise reduction unit that is optionally connected to the input and the amplification unit, which Lindemann, as previously shown by the Applicant, does not teach. Accordingly, the Applicant submits that the Examiner's arguments towards claim 29 are no longer relevant. The Applicant respectfully submits that claim 29 is novel and inventive over the cited reference and is therefore allowable.

With regards to claim 22, in the Office Action, the Examiner argued that Lindemann teaches that the main noise reduction unit comprises a detector (microphone 16) connected to an input and providing a detection level indicative of the presence of speech, a magnitude means (MAGSQ 154) for determining the magnitude spectrum of the input signal with both the detector and the magnitude means being connected to the input of the apparatus, a spectral estimate means (beam spectrum subtract gain 158) for generating a noise magnitude spectral estimate and being connected to the detector and the input of the apparatus, and a noise filter calculation unit (160, 162) connected to the spectral estimate means and the magnitude means for receiving the noise magnitude spectral estimate and the magnitude spectrum of the input signal and calculating an attenuation function, and a multiplication unit (202) coupled to the noise filter calculation unit and the input signal for producing the noise reduced signal.

In response, the Applicant respectfully submits that claim 22 now depends on claim 21 which recites a main noise reduction unit that is optionally connected to the input and the amplification unit. As previously shown by the Applicant, Lindemann does not teach this structure.

Secondly, the Applicant submits that the microphone (16) taught by Lindemann is not a detector of speech as taught and claimed by the Applicant in claim 22. The microphone (16) provides a sound level irrespective of whether speech, noise or any other signal that is transduced by the microphone (16). Accordingly, the microphone (16) does not provide a detection signal indicative of the presence of speech as claimed by the Applicant in claim 22.

Thirdly, the beam spectrum subtract gain block (158) taught by Lindemann is not a spectral estimate means for generating a noise magnitude spectral estimate as claimed by the Applicant in claim 22. The beam spectrum subtract gain block (158) provides a direction estimate "d" related to the values in the frequency bands of the LEFT and RIGHT inputs of the Lindemann hearing aid.

Fourthly, the noise filter calculation unit (160, 162) taught by Lindemann is not connected to the spectral estimate means and the magnitude means for receiving the noise magnitude estimate and calculating an attenuation function as claimed by the Applicant in claim 22. Rather, the filters (160, 162) are part of the beam spectrum subtract gain block (158) and receive the inner product average and the magnitude square sum of the LEFT and RIGHT input signals. Furthermore, the filters (160, 162) do not calculate an attenuation function but rather provide simple lowpass filtering.

In light of these noted differences, the Applicant respectfully submits that claim 22 is novel and inventive over the cited reference and should be allowed.

CLAIM REJECTIONS – 35 USC s. 103(a)

In the Office Action, the Examiner made an obviousness rejection to claims 21, 27 and 28 under 35 U.S.C. 103(a) as being unpatentable over Salmi et al. (U.S. 5,903,655) hereafter referred to as "Salmi".

With regards to claim 21, the Examiner argued that Salmi teaches a hearing aid system for reducing noise in an input signal by using bandpass filters which only let signals in selected frequency bands pass through thereby reducing unwanted signals. In particular, the Examiner argued that the hearing aid system includes an input for receiving the input signal, a compression circuit (48) for receiving a compression control signal and generating an amplification control signal (volume control 18 for output amplifier 20), an amplification unit (output amplifier 20) for receiving the input signal and the amplification control signal and generating an output signal (to speaker 22) with compression and reduced noise (through band pass filter 44), and an auxiliary noise reduction unit (band pass filter 44) which only lets signals in a selected frequency band pass through thereby reducing unwanted signals.

In response, the Applicant submits that Salmi does not teach the structure that is taught by the Applicant and claimed in amended claim 21. In particular, amended claim 21

specifies that the amplification unit receives the input signal and the amplification control signal and generates an output signal with compression and reduced noise under the control of the amplification control signal. Amended claim 21 further specifies that the apparatus includes a main noise reduction unit that is optionally connected to the input and the amplification unit so that the apparatus can either provide the single input signal to the amplification unit or provide a noise reduced version of the single input signal to the amplification unit. This is beneficial depending on the particular quality of the signal and noise as previously discussed by the Applicant.

Salmi does not teach this configuration. Rather, in Figures 1, 2a, 2b, 2c, and 5-11, Salmi teaches summing the input signal and a filtered, compressed, and attenuated version of the input signal and applying the summed signal as the input to an output amplifier. Salmi clearly does not teach providing a separate signal to the output amplifier to control the amount of amplification that is provided by the output amplifier. In addition, none of the various compression systems disclosed by Salmi involve optional noise reduction units.

Accordingly, the Applicant respectfully submits that claim 21 is novel and inventive over the cited reference and is therefore allowable. Furthermore, since claims 22 to 24 and 28 to 30 depend from independent claim 21, and introduce other patentable features, the Applicant respectfully submits that claims 22 to 24 and 28 to 30 are also allowable.

With regards to claim 27, the Examiner argued that Salmi teaches that the apparatus further comprises a main noise reduction unit (bandpass filter 42) connected to the input (microphone 12) for generating a noise reduced signal and supplying the noise reduced signal to the amplification unit (output amplifier 20) in place of the input signal.

Since the Applicant has deleted claim 27 without prejudice, the Applicant submits that this rejection is no longer applicable. However, the Applicant would further like to point out that in Salmi, the noise reduced signal is not provided to the amplification unit in place of the single input signal since a version of the noise reduced signal (the output of

the volume control block 18) is summed (summer 24) with an amplified version of the input signal (the output of amplifier 14) and the summed signal is provided to the output amplifier (20).

With regards to claim 28, the Examiner argued that the main noise reduction unit (bandpass filter 42) and the auxiliary noise reduction unit (bandpass filter 44) employs the same noise reduction filtering.

In response, the Applicant submits that claim 28 is dependent on claim 21 and that Salmi does not claim the structure as now claimed by the Applicant in claim 21. Accordingly, the Applicant respectfully submits that claim 28 is novel and inventive over the cited reference and is therefore allowable.

In the Office Action, the Examiner rejected claims 23-24 under 35 USC 103(a) as being unpatentable over Lindemann in view of Handel (PCT WO 96/24128).

With regards to claim 23, the Examiner argued that Lindemann teaches an apparatus as claimed in claim 22 and that Lindemann further teaches a frequency transform means (FFT) connected between the input (LEFT IN) and both of the magnitude means (sum MAGSQ 154) and the spectral estimate means (beam spectrum subtract gain 158) for transforming the signal into the frequency domain to provide a transformed signal wherein the magnitude means determines the magnitude spectrum from the transformed signal and wherein the spectral estimate means determines the noise spectral estimate.

The Examiner further argued that although Lindemann does not teach how the spectral estimate means determines the noise spectral means from the transformed signal, Handel does teach reducing noise in an input containing speech and having a signal to noise ratio and in the absence of speech determining a noise spectral estimate. The Examiner further argued that it would be obvious for one of ordinary skill in the art to incorporate Handel's teaching with Lindemann.

In response, the Applicant respectfully submits that Lindemann does not teach an apparatus as claimed in claim 22. Firstly, claim 22 depends on amended claim 21, and as previously discussed in this response, Lindemann clearly does not teach the structure of amended claim 21. Further, as previously discussed in this response, Lindemann does not teach the structure recited in claim 22.

Furthermore, claim 23 recites that the spectral estimate means determines the noise spectral estimate in the absence of speech. The Applicant submits that this functionality is not taught by Lindemann and cannot be provided by Lindemann's apparatus since there is only a voice detect gain scale block in the apparatus and Lindemann does not show that this block provides any voice detection information to the SUM MAGSQ block 154. In addition, the BEAM SPECTRAL SUBTRACT GAIN BLOCK 158 is not a spectral estimate means as taught and claimed by the Applicant since Lindemann teaches that block 158 simply provides a direction estimate (see line 51, col. 9 to line 13, col. 10).

Accordingly, the Applicant respectfully submits that claim 23 is novel and inventive over the cited references and is therefore allowable and as well as claim 24 since claim 24 depends from claim 23 and introduces other patentable features.

Conclusion

In view of the foregoing comments, it is respectfully submitted that the application is now in condition for allowance. If the Examiner has any further concerns regarding the language of the claims or the applicability of the prior art, the Examiner is respectfully requested to contact the undersigned at 416-957-1603.

Respectfully submitted,

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